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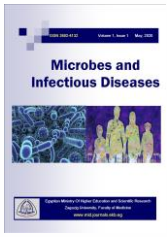

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Original article

Bacteria diversity of two abattoir effluents in Ikpoba Hill and Oluku, Benin City, Nigeria and their potential public health implications

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ABSTRACT

Background: Slaughterhouse or abattoir are usually the starting point of most meat processing industry especially in communities where the stock comes directly from the market or farms to the food chain. Meat is processed fresh for consumers and traders alike in these facilities and as a critical component of the livestock industry, a major source of meat supplies and employment in Nigeria. However, the activities and processes in these abattoirs when mishandled, are often a direct or an indirect source of pollution in the environment. When improperly treated, the effluents from these abattoirs constitute a significant environmental and health hazard. **Aim:** This study investigated the bacteria diversity of the effluents from the Ikpoba Hill and Oluku abattoirs and their public health implications. **Methods:** 1and half liters effluents samples, were collected from the two abattoirs. 25 ml of effluents mixed with 225 ml of buffered peptone water (1 in 10 dilution) from where other dilutions were obtained and Phenotypic identification of microbes was performed according to standard methods. The organisms were isolated using the trypticase soy agar (TSA) media. **Results:** A total of 5 distinct bacterial isolates (*Escherichia coli (E.coli), Pseudomonas aeruginosa, Bacillus substilis, Klebsiella pneumonia, and Enterococcus faecal*is) were isolated from the effluents. The percentage occurrence of the organisms isolated from abattoir A were *E. coli* (31.1%), *Pseudomonas aeruginosa* (24.5%), *Enterococcus faecal*is (18.6%), *Bacillus substilis* (17.6%), and *Klebsiella pneumonia* (8.2%) while the percentage occurrence of the isolates in abattoir B were *E. coli* (35.3%), *Pseudomonas aeruginosa* (20.7%), *Bacillus substilis* (19.3%), *Streptococcus faecalis* (17.3%), and *Klebsiella pneumonia* (7.4%). **Conclusion:** The study concludes that some of these organisms isolated from these effluents constitute potential public health hazards. It is recommended that effluents from these abattoirs be properly treated before releasing them to the environment.

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Introduction

Slaughterhouse or abattoir are usually the starting point of most meat processing industry especially in communities where the stock comes directly from the market or farms to the food chain. Meat is processed fresh for consumers and traders alike in these facilities and as a critical component of the livestock industry, a major source of meat supplies and employment in Nigeria [1,2]. However, the activities and processes in these abattoirs when mishandled, are often a direct or an indirect source of pollution in the environment [3]. When improperly treated, the effluents from these Abattoirs could constitute a significant environmental and health hazard, contaminating the river body and land [4,5]. The presence of feces, manure, blood, fats, grease, hair, grit and undigested feeds make these effluents a rich source of organic matter [6,7].These effluents are a rich source of high level of salts, phosphates, nitrates and oxygen-consuming waste.

Energy consuming wastes are capable of making the soil become less available as an electron acceptor when they drain into the soil which can negatively impact denitrifying bacteria to reduce available nitrate to gaseous nitrogen entering the environment. In the same vein, the anaerobic methanogens could also be affected causing them to produce excessive methane at a higher rate than aerobic methane-oxidizing bacteria(methanotrophs) could cope with thus contributing to greenhouse effect and global warming. These effluents also impact the microbial flora and fauna communities, alter the physicochemical properties of the soil such as the pH when elements such iron, lead, phosphorus, calcium and zinc previously absent or present in minute quantities are introduced resulting in the magnification of these chemicals. Sadly, most abattoir in Nigeria lack the facilities for the treatment of abattoir effluents, unlike in developed countries where these facilities are adequately provided [8].

The animals slaughtered in Ikpoba hill and Oluku abattoirs accounts for a substantial percentage of the total animals slaughtered in the Benin metropolis of Nigeria, the largest city in and capital of the Edo state with an estimated population of 1,125,058 as at 2021 [9]. The wastes from the slaughtering and dressing ground in the abattoirs usually drains into the surrounding soil environment untreated, while the remaining is channeled through the abattoir drainages into Ikpoba river (also Oken River) a fourth order stream situated within the rainforest belt of Edo State as well as the rivers in Oluku and environs respectively. Industrial effluents and water from drainage channels are also discharged into the river at various points as well including that of a government abattoir managed by the local government, situated by the river where as much as 50 cows and goats are reported to be slaughtered daily [10]. These two rivers are of particularly importance to the people of Benin City, including the construction of one of the major dams in Edo State across the river in Okhoro community. This study therefore investigated the bacteria diversity of the effluents from the Ikpoba Hill and Oluku abattoirs.

Materials and Methods

The study area

The state abattoir is situated at Ikpoba, Ikpoba-Okha Local Government area and Oluku, Benin, Edo State. The study areas are located on longitude 6.1649° N, Latitude 5.6879° E and longitude 6.4305° N, latitude 5.5932° E, respectively.

Sample collection

One and half (1.5) liters effluents samples, were collected from the two abattoirs. 25 ml of effluents mixed with 225 ml of buffered peptone water (1 in 10 dilution) from where other dilutions were obtained. The abattoirs were located in Ikpoba hill (Ikpoba-Okha Local Government) Benin, Edo State, Nigeria. Both abattoirs are adjacent each other. The Bijou bottles were used to aseptically draw part of the effluents running off the drainage system just as it was leaving the slaughter pavement. Five samples were collected from each site. All samples were well labelled and transported to the laboratory in an ice-parked container for analyses immediately after collection.

Identification and characterization of bacteria

Phenotypic identification of microbes was performed according to standard methods [11] The organisms were isolated using the trypticase soy agar (TSA) media. Morphological traits examined includes the orientation, size, and pigmentation which were performed by visual inspection of microbial isolates on petri-plates, as well as cell wall

characteristics which was performed by Gram staining of the isolates. Biochemical traits examined were the production of coagulase enzyme (coagulase test); the production of catalase enzyme (catalase test); the ability of the organism to produce the cytochrome oxidase enzyme (Oxidase test); the production of urease enzyme (urease test); utilization of citrate as a sole carbon source (citrate test); biodegradation of tryptophan to produce indole (indole test); production of stable acids from glucose fermentation (methyl red test); production of acetoin as the main end product with small quantities of mixed acids from glucose metabolism (Voges Proskauer test); the ability to form organic compounds by metabolizing certain carbohydrates (mannitol and lactose tests).

Results

Table 1. The total mean viable counts for bacterial isolates in the effluents.

Effluent Samples	Total heterotrophic mean counts (x^{10} cfu/ml)	
	Abattoir A	**Abattoir B**
1	212	194
2	243	211
3	230	201
4	243	161
5	261	176
X ± S.E	237.8*	188.6

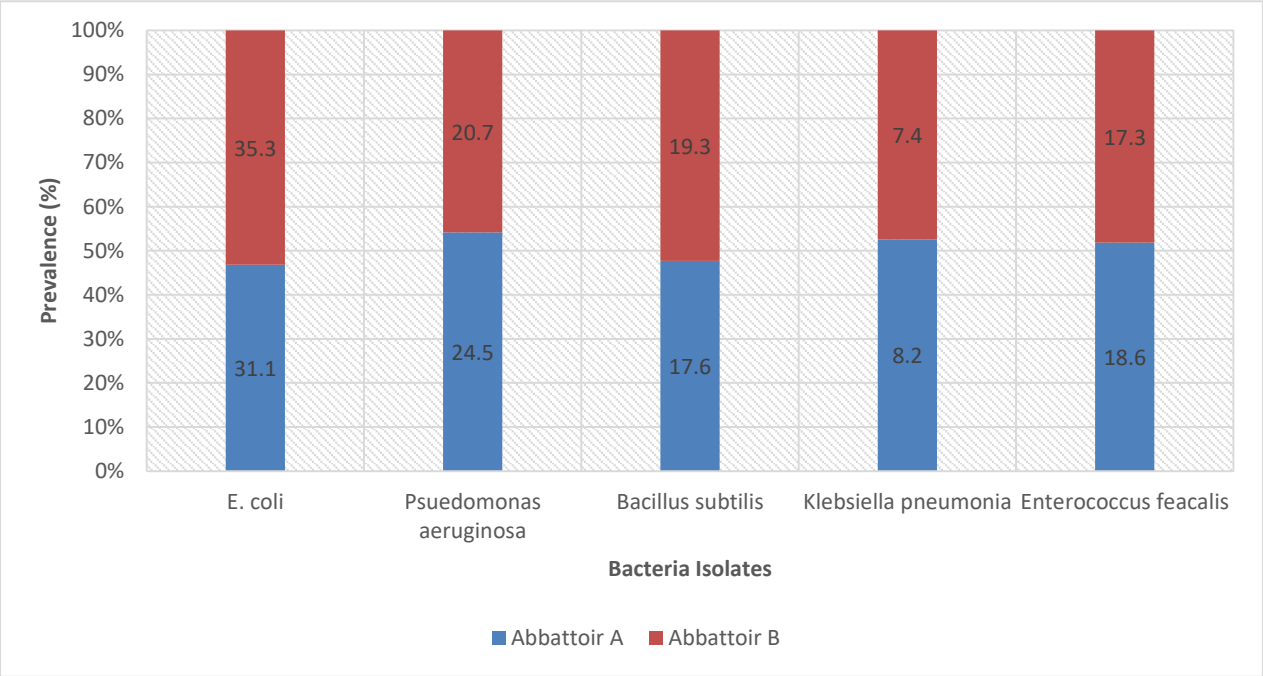
Key: *shows that the average mean value of abattoir A is significantly higher than that of abattoir B at 5% level of significance ± Standard Error (S.E)

Table 2. Phenotypic characterization of microbial isolates obtained from abattoir effluents.

Isolates	Colonial characteristics on TSA Plates	Microscopic characteristic	Biochemical tests										Probable organism
			Co	**Ca**	**Ox**	**Ur**	**Ci**	**In**	**Mr**	**Vp**	**Ma**	**La**	
1	Mucoid colony	Gram negative rods	-	+	-	-	-	+	+	-	-	+	*E. coli*
2	Greenish pigmented colony	Gram negative rods	-	+	+	-	+	-	-	-	-	-	*Pseudomonas aeruginosa*
3	Seriated dry colony	Gram positive rods	-	+	+	-	+	-	-	+	v	-	*Bacillus substilis*
4	Mucoid colony	Gram negative rods	-	+	-	+	+	-	-	+	-	+	*Klebsiella pneumoniae*
5	Greenish pigmented colony	Gram negative rods	-	+	+	-	+	-	-	-	-	-	*Pseudomonas aeruginosa*
6	Mucoid colony	Gram positive cocci	-	-	-	-	-	-	-	+	+	+	**Enterococcus faecalis*

Key: Co: coagulase; Ca: Catalase; Ox: Oxidase; Uri: Urease; Ci: Citrate; In: Indole; Mr: Methyl Red; Vp: Voges Proskauer; Ma: Mannitol; La: lactose; V: Variable (+/-); *previously *Staphylococcus faecalis.*

Figure 1. Prevalence of bacteria isolates from abattoir effluent.



Discussion

The results of the percentage frequency of occurrence of the bacterial isolates are presented in **figure (1)**. A total of 5 distinct bacterial isolates (*E. coli*, *Pseudomonas aeruginosa*, *Bacillus substilis*, *Klebsiella pneumonia, and Enterococcus faecal*is) were recorded from the study samples **(Figure 1)**. In the effluent samples collected from abattoir A, the percentage frequency of occurrence was *E. coli* (31.1%), *Pseudomonas* sp. (24.5%), *Enterococcus faecal*is (18.6%), *Bacillus substilis* (17.6%), and *Klebsiella pneumonia* (8.2%) **(Figure 1)**. In the effluent samples collected from abattoir B, the percentage frequency of occurrence was *E. coli* (35.3%), *Pseudomonas aeruginosa* (20.7%), *Bacillus substilis* (19.3%), *Streptococcus faecalis* (17.3%), and *Klebsiella pneumonia* (7.4%). It was generally observed that *E.coli*, had the highest frequency of occurrence in samples from both abattoir effluents samples with *Klebsiella pneumonia* having the lowest frequency of occurrence.

Escherichia coli and *Enterococcus faecal*is are coliforms and thus indicator organisms of fecal contamination. The presence of *E. coli* is also used as an indicator to monitor the possible presence of other more harmful microbes, such as Cryptosporidium, Giardia, Shigella, and norovirus. Although *E. coli* is usually not a cause for concern, a few virulent strains can cause serious diseases in humans. When the *E. coli* strain O157:H7 contaminates meat and leafy vegetables, it can cause serious hemorrhagic diarrhea with either long term effects that is either fatal or with complications. Certain strains of *E. coli* have been majorly implicated in foodborne illness [12]. The organism mostly implicated in traveler's diarrhea is the Enterotoxigenic *E. coli* (ETEC) with as many as 840 million cases reported worldwide annually in developing countries. *E. coli* is typically transmitted through contaminated food or drinking water, adheres to the intestinal lining, where it secretes either of two types of enterotoxins (cytotoxic and cytotonic), leading to watery diarrhea. The rate and severity of infections are higher among children under the age of five, including as many as 380,000 deaths annually [12]. Some of the other known disease associated with such contaminated water are gastrointestinal illness, skin, ear, respiratory, eye, neurologic, and wound infections [13]. Since most of the inhabitants around the river and its water banks depends heavily on the water from these rivers for domestic use, it may result in illness and contribute significantly to the disease burden in those areas. *Enterococcus faecalis* is an important opportunistic pathogen. which is frequently detected in mineral water and spring water for

human consumption and causes human urinary tract infections, endocarditis, wound infection, abdominal abscesses and neonatal sepsis [14].

Pseudomonas aeruginosa though implicated in some infections, is mostly at risk to people with serious illness or other predisposing factors. It mainly colonizes damaged sites such as burns and surgical wounds, the airways of people with underlying diseases, and physically damaged eyes, from whence it invades the body, causing destructive damage or sepsis and meningitis. Immunocompromised cystic fibrosis patients are particularly prone to colonization by *Pseudomonas aeruginosa*, which can lead to severe progressive lung infections. Water-related folliculitis and ear infections are associated with hot, humid environments such as swimming pools and spas. Many strains are resistant to a variety of antimicrobial agents, which can increase the organism's importance in a hospital setting. The main route of infection is exposure of sensitive tissues, including wounds and mucous membranes, to contaminated water or contamination of surgical instruments. Cleaning contact lenses with contaminated water can cause a form of keratitis. Ingestion of drinking water is not a major source of infection. On the other hand, *Bacillus substilis* is considered harmless. *Klebsiella spp.* are not considered to represent a source of gastrointestinal illness in the general population through ingestion of drinking-water. *Klebsiella* spp. detected in drinking-water are generally biofilm organisms and are unlikely to represent a health risk

Conclusion

The study concludes that the effluents from the investigated abattoir constitute potential public hazards to the environment. There is therefore the need to treat effluents from abattoirs before channeling then into water bodies to reduce environmental pollution capable of increasing public health disease burden associated with such contamination.

Conflict of interest: None.

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